(12) **EUROPEAN PATENT APPLICATION**

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(54) **Voice over Internet protocol network architecture**

(57) Voice and media services are provided over an IP network incorporating a plurality of nodes and in which connection oriented traffic is transported in tunnels via said nodes. SS7 signalling is provided between nodes. The voice and media components are multiplexed to form a point to point protocol (PPP) session which is switched end to end across the network under the control of the signalling.

Figure 4
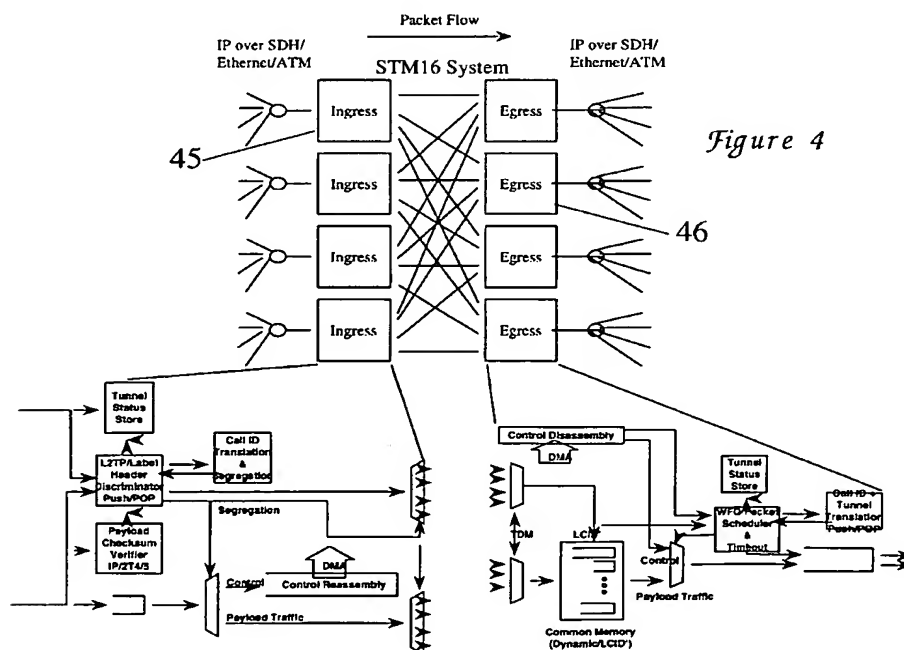
EP 1 001 577 A1

Description

[0001]   This invention relates to systems and methods for providing and managing Internet protocol (IP) connection oriented services.

BACKGROUND OF THE INVENTION

[0002]   The Internet Protocol was initially defined for connectionless services. These services normally operate on a best effort basis. There is now a keen interest in the provision of voice services over the Internet where costs are significantly less than those associated with the conventional PSTN. However, the adaptation of what is effectively a high priority connection oriented service to a 'best effort' connectionless or packet system has introduced a number of significant problems. In particular, if an Internet voice service is to obtain universal acceptance, it must provide a quality of service similar to that currently provided by conventional voice networks.

[0003]   A number of workers are currently addressing this problem. For example, the current Internet Ipv4 protocol includes a TOS (type of service) octet, and Ipv6 a traffic class octet which allows a number of priority levels to be defined to support some degree of traffic engineering in an IP network. The IETF Differentiated Services Working Group has recently defined a method whereby traffic is classified at a priority level and is policed on entry to an IP network. Traffic behaviour on internal links (per hop behaviour) is specified. It is expected that using these methods then service level agreements can be offered to users provided that the number of internal hops is low and also provided that the percentage of high priority traffic is a small percentage of the total traffic.

[0004]   Other IETF Working Groups have defined protocols providing some degree of connection orientation. These are:-

  Multi Protocol Label Switching (MPLS) includes the ability to tunnel through many routing stages and to do so using explicit routing rather than hop-by-hop routing. This is a form of connection orientation.

  Layer 2 Tunnelling Protocol (LTP) provides a signalling system to dynamically create and delete IP point to point protocol (PPP) sessions end to end across a tunnel. These sessions are allocated bandwidth, are timed for billing purposes, and are explicitly deleted on completion. This is a fully connection oriented paradigm.

[0005]   Connection orientation is of particular value in the provision of carrier network services to individual users or to user networks. In particular it simplifies the tasks of:-

  Guaranteeing bandwidth.
  Ensuring Quality of service.
  Authenticating end user identities.
  Preventing fraudulent access or misuse of resources.

[0006]   Existing Layer 2 networks such as Frame Relay or ATM are able to provide an effective control framework to provide bandwidth accounting however their control protocols are not sufficiently integrated into the Layer 3 IP network functionality to ensure that QoS characteristics of user services are maintained. This has limited the exploitation of this characteristic and has thus failed to resolve the provision of QoS in the Internet.

[0007]   Reference is here directed to our co-pending application of even date (reference ID1068), the contents of which are incorporated herein by reference, which relates to a network architecture in which a network of layer 2 protocol (L2TP) tunnel switches provides an end of end connection oriented operation for PPP sessions.

SUMMARY OF THE INVENTION

[0008]   An object of the invention is to minimise or to overcome the above disadvantage.

[0009]   In addition it is recognised that ITU Signalling System No 7 (SS7) is of considerable value in Voice over IP networks as it allows access to Intelligent Network applications of the PSTN/ISDN and also provides service transparency whereby services such as Call Waiting can operate consistently for ISDN to ISDN, VoIP to ISDN and VoIP to VoIP calls.

[0010]   In a first aspect, the invention provides an arrangement for providing voice and media service components over an IP network incorporating a plurality of nodes and in which connection oriented traffic is transported in tunnels via said nodes, the arrangement comprising means for providing signalling between said nodes, and means for multiplexing the voice and media components to form a point to point protocol (PPP) session, and means for switching said PPP session end to end across the network under the control of said signalling.

[0011]   In another aspect, the invention provides a method of providing voice and media service components over an IP network incorporating a plurality of nodes, the method comprising providing signalling between said nodes, and multiplexing the voice and media components to form a point to point protocol (PPP) session which session is switched end to end across the network under the control of said signalling.

[0012]   Preferably, the signalling comprises SS7 signalling.

[0013]   Typically, the network tunnels comprise Layer 2 Tunnelling Protocol (L2TP) tunnels and Multi Protocol Label Switching (MPLS) tunnels.

[0014]   In a preferred embodiment, gatekeepers are

provided at either end of each tunnel so as to control the number of calls admitted to that tunnel. This enables the provision of quality of service guarantees to the admitted traffic.

[0015] This invention thus provides a network architecture for Voice over IP services in which e.g. SS7 signalling is used between Voice over IP nodes and the media components between the VoIP terminals are multiplexed to form a PPP Session which is switched end to end across the wide area network.

BRIEF DESCRIPRION OF THE DRAWINGS

[0016] A preferred embodiment of the invention will now be described with reference to the accompanying drawings in which:-

Figure 1, illustrates the MPLS mechanisms for tunnelling and explicit routing;

Figure 2 illustrates the MPLS label processing functions performed in routing a packet through an example connection oriented tunnel of figure 1;

Figure 3 illustrates the establishment of an IP (PPP) session in an L2TP tunnel;

Figure 4 illustrates a hardware fabric employed in a preferred embodiment of the invention and which is arranged to operate as a Layer 3 MPLS Router, a Layer 2 MPLS Tunnel Switch and a Layer 2 IP (PPP) Session Switch;

Figure 5 and the associated flow chart of figure 5a together illustrate the establishment of an end-to-end IP (PPP) Session having bandwidth guarantees and enabling the end-to-end operation of standard PPP authentication and encryption protocols;

Figure 6 illustrates the IP Network Configuration of this invention; and

Figure 7 shows a message sequence chart for the establishment of a successful call between two Voice over IP terminals.

DESCRIPTION OF PREFERRED EMBODIMENT

[0017] Reference will first be made to figures 1 to 3a which are introduced for comparative and explanatory purposes, and for the purpose of facilitating a fuller understanding of the invention.

[0018] Referring to figure 1, which is introduced for explanatory and comparative purposes, this shows a prior art MPLS network. The network comprises a number of MPLS edge routers 11 and MPLS switching nodes 12. Such a network allows tunnels to be defined

and used for explicit end to end routing of packets. Packet traffic contained within a tunnel passing through a switching node is effectively ignored by that node as far as routing is concerned. The tunnels can be defined at several layers, and tunnels of one layer can be carried within tunnels of other layers. For the purpose of illustration, engineering tunnels 13a, 13b etc. are defined for an engineering layer which is used to divide up capacity in the physical network, and user tunnels 14, which utilise capacity of the engineering tunnels, are defined in order to provide end user services. An engineering tunnel may of course accommodate a number of user tunnels, and a user tunnel will, in general, pass through more than one engineering tunnel. As shown in figure 1, the user tunnel 14 is contained in the engineering tunnels 13a and 13b. A typical end user service would be a guaranteed bandwidth service between two VPN user nodes.

[0019] In the network of figure 1, an engineering tunnel is a permanent or semi-permanent entity that is set up across a number of network nodes, but which does not in general provide a complete end to end route across the network. A user tunnel is a temporary entity that is set up within an appropriate number of engineering tunnels to provide end to end connectivity for the duration of a network transaction, and which is torn down when that transaction has been completed. The purpose of a tunnel is to facilitate routing of packets. A packet within a tunnel can pass through a node without that node needing to have any knowledge of the destination of that packet, nor even of the next node at which the packet will arrive, as the packet can remain within the tunnel until emerging at its final destination. The only information required by the node is the identity of the tunnel via which the packet is transported. It will be understood that an IP network incorporating the tunnel concept may carry both tunnelled packet traffic and conventional packet traffic that is routed at each system node through which it passes.

[0020] The multi protocol label switching (MPLS) operation of the network of figure 1 is depicted in figure 2 which illustrates the typical packet format P1-P6 at each of the stages in the routing of an IP packet payload end to end across the network of figure 1. A typical MPLS packet comprises the original IP packet together with a stack of labels which are used by the MPLS nodes 12 through which the packet passes to control the onward routing of the packet. At each node, the current packet label is used to determine the onward routing of the packet, i.e. the tunnel to which the packet is allocated. The labels are typically each of 4 bytes length comprising a 20 bit label value, a 3 bit class of service field, used to maintain QoS differentiation, a 1 bit "bottom of stack" indicator and an 8 bit "time to live" field, which is used to detect packet forwarding loops.

[0021] The packet formats P1-P6 are selected in order to achieve explicit forwarding of the packet over a user tunnel which is itself contained within first and sec-

ond engineering tunnels in order to reach the destination edge router. MPLS is designed such that it is possible, at each node, to forward the packet based on the label at the top of the stack.

[0022] As shown in figure 2, the packet format P1 has labels L-d, L-u1, and L-ex. The label L-d is significant to the destination edge router 11b and is a label exchanged by the label distribution protocol over the user tunnel. L-u1 is the first label of a series used for the user tunnel and is exchanged over the first engineering tunnel 13a. L-ex is a label for the engineering tunnel 13a.

[0023] The packet format P2 is used by the first node 12 to determine that this is the penultimate node for the first engineering tunnel 13a. This leads to a "pop" of the stack so that the labels L-d and L-u1 are forwarded to the next node. It will be understood that the term "popping" of a label stack refers to the removal of the label currently at the head of the stack, and that the term "pushing" of a label refers to the addition of a label to the stack.

[0024] The label L-u1 of the packet format P3 is used to forward the packet and is translated to the label L-u2 for the next hop.

[0025] The label L-u2 of the packet format P4 is used for forwarding. It is determined that this is the penultimate hop from the perspective of the user tunnel so label L-u2 is popped. It is also determined that the second engineering tunnel 13b is used, L-ey being a label for the engineering tunnel 13b. The packet is therefore forwarded with the labels L-d and L-ey.

[0026] At the penultimate node of the second engineering tunnel 13b, the label L-ey of the packet format P5 is popped so the packet arrives at the destination edge router 11b with the label L-d only.

[0027] At the destination edge router 11b, the original IP packet (format P6) is forwarded to the final destination on the Lan.

[0028] A further example of tunnelling prior art, illustrated for explanatory and comparative purposes in figures 3 and 3a, is the layer 2 tunnelling Protocol (L2TP). L2TP is used for dial-up services where the point of network service is different from the point at which the original dialup call is made. An example is Internet service provider (ISP) roaming whereby the dialup is terminated at the nearest ISP but the network service is provided by the original or home ISP. L2TP provides a connection signalling mechanism so that point to point protocol (PPP) sessions can be dynamically multiplexed within the tunnel. PPP payload packets have a short header prepended thereto so that the original PPP packets can be identified and forwarded as appropriate.

[0029] Figure 3 further illustrates a new call from a user terminal 30 arriving at a L2TP access concentrator (LAC) 31 from a dial-up modem connection set up via a PSTN 32. The associated messaging is illustrated in figure 3a. It is determined that the call is destined for a remote L2TP network server (LNS) 33 coupled to IP network 35. A user tunnel 34 is thus established across the

IP network between the concentrator 31 and the remote server 33. An exchange of messages within the L2TP tunnel 34 leads to an allocation of a call ID within the tunnel 34 which can be used to identify packets in both directions related to this call.

[0030] Having described the prior art network operation in order to facilitate a fuller understanding of the invention, preferred embodiments of the invention will now be described by way of example with reference to figures 4 to 7 of the accompanying drawings.

[0031] Referring first to figure 4, this depicts the inner core and the surrounding circuitry of a router or switch according to a preferred embodiment of the invention. As shown in figure 4, the switch incorporates an inner core 40 comprising a set of ingress functions 45 coupled to respective ingress ports 47, and a set of egress functions 46 coupled to respective egress ports 48. Any ingress function can route a received packet to any egress function. The ingress and egress ports coupled to the respective ingress and egress functions handle packet traffic that is routed from node to node, i.e. not contained within a tunnel. Tunnel based traffic is received e.g. from tunnel T41 which either terminates at or passes through the node. The tunnel T41 may be an engineering tunnel accommodating a number of user tunnels.

[0032] The lower half of figure 4 shows a decomposition of the ingress and egress functions of the switch. A Tunnel Status store provides an identification of whether the tunnel type is MPLS or L2TP and also the maintenance status of the tunnel. This is used by the L2TP/label header discriminator to access the header information and to execute any required Push/Pop operation. The header information is used to access the Call Id translation & segregation function in order to identify the required egress function and to modify the L2TP headers for onward transmission. The packet is then forwarded on a link to the required egress function. In the typical switch fabrics, e.g. ATM, the packet will have been segmented for transport purposes. In this case the packet is reassembled in the egress function for egress control purposes, the header of the packet as modified by the ingress function providing all the control information required for egress. The tunnel status store discriminates between MPLS and L2TP operation. The header can be further processed by additional push/pop operations or by Tunnel id/Call id translations. The packet is then passed to the scheduler for transmission. Advantageously, the scheduler includes a weighted fair queuing function in order to maintain a fair discard operation in the event of overload.

[0033] In the arrangement of figure 4, IP packets that are received at the switch from tunnel T41 are output into tunnel T42. If the IP packets are already in MPLS format then they are directly forwarded to the inner core 41 of the switch. For IP Packets which are in their normal format, an additional function, not shown, is required to process the IP address and establish an MPLS label according to the forwarding equivalence class, i.e. the set

of IP addresses which share a common MPLS label. The provision of such a function will be understood by those skilled in the art. A switch on a single card is typically made up from four VLSI components, each of which provides 622 MB/s of switching capacity. Each VLSI component comprises an ingress function 45 and an egress function 46. The ingress function 45 processes the initial MPLS label. For normal MPLS packets, a treatment indicator determines whether to PUSH/POP the label stack and/or translate the label. Where the initial MPLS label indicates that an L2TP tunnel is contained within the label, then a second pass is performed interpreting the second header as an L2TP header with its own treatment indicator. The initial ingress function 45 selects an egress port 48 for forwarding. The packet is segmented by the ingress port 44 and forwarded typically as 64 byte segments to the egress port. The egress port reassembles the packet and has an additional treatment indicator, which it uses to prepend the final headers and labels before forwarding the packet on to the next switching node.

[0034] The switch architecture of figure 4 embodies a connection control architecture which provides a range of connection oriented services in Internet Protocol (IP) networks. This architecture, which applies recursively at multiple levels, can be used to establish engineering tunnels in the physical network and user tunnels within these engineering tunnels. The architecture can also be used to establish PPP Sessions within a succession of L2TP tunnels. The L2TP tunnels can be mapped onto MPLS tunnels, and the MPLS tunnels can hide details of the IP network topology from the L2TP layer network Referring now to figures 5 and 5a, these figures illustrate an exemplary embodiment in which two system nodes generally indicated as 10, each incorporating a respective L2TP tunnel switch 11, are interconnected through an ATM network 12. Each tunnel switch 11 is associated with a respective session manager 13. An application server 14 associated with the TM network 12 operates on a proxy signalling basis and requests point to point protocol (PPP) sessions on behalf of its clients. Each PPP session request identifies its respective endpoints using layer 2 tunnelling protocol (L2TP) addressing with the address space covering a full E164 number. The system operates on a source routed basis as in the case of the ATM Forum PNNI signalling system. The system nodes 10 exchange topology state packets identifying the network topology and reporting on available bandwidth or congestion so that each node has a picture of the current status of the network. For example, a session request (A, B , DTL(N1,N2)) is a request for a PPP session between users A and B with a designated transit list (DTL) for network nodes N1 and N2. The topology state packets that are exchanged between the nodes provide sufficient information on bandwidth availability to ensure that the nodes N1 and N2 have a high probability to provide a successful routing.

[0035] In the network of figure 5, each L2TP Tunnel exchanges the standard sequence of messages defined for L2TP; i.e. Call Request, Call Reply and Call Connected. These messages may relate to outgoing calls or incoming calls. The session managers link the partial PPP sessions on each tunnel in order to provide an end to end PPP session via the tunnel.

[0036] In figure 6 a preferred network configuration that exploits the capabilities of the tunnel network of figure 5 to deliver voice over IP services is shown. A number of H.323 client terminals 21 operate on a LAN together with an H.323 gatekeeper 22, a number of proxy servers 23 and a tunnel switch 24. The proxy servers 23 act as the endpoints of the tunnels so that the H.323 client terminals are not restricted in the applications that they can support in addition to the H.323 client. Advantageously, each gatekeeper 22 incorporates a call server function which is able to operate SS7 signalling with other gatekeepers or with PSTN/ISDN switches (not shown) in the external network.

[0037] The message sequence chart of figure 7 illustrates the end to end operation for a successful call set up in the network of figure 6. H.323 clients with E164 numbers A and B have respective proxy servers with E164 numbers P_A and P_B where A and P_A are algorithmically related. As shown in figure 7, user terminal A sends a set-up message (set-up(A,B)) for a call to user terminal B. This message is converted by the gatekeeper associated with the user terminal into an SS7 IAM message (IAM(P_A,B,OPC=N1,DPC=N2,CICx) in which the originating point code (OPC) or destination point code (DPC) designate the particular combination of the gatekeeper and the tunnel switch. The circuit identification code (CIC) designates a PPP session that is to be created on an L2TP Tunnel between the two tunnel switches. On receipt of the alerting message from the called user terminal B in response to the set-up request, the terminating gatekeeper requests a PPP session. This proceeds as described with reference to figure 1a above. The PPP session identifier of the proxy server P_A (Tunnel ID, Call ID) is passed back to the terminating gatekeeper. This information is also passed to the originating gatekeeper as user to user information in the SS7 answer message ANM. This information allows the originating gatekeeper to complete the end to end connection. The L2TP signalling sequences exchange physical channel Ids, typically IP addresses, to enable packets to be exchanged between the proxy servers.

[0038] Following the set-up of the connection, H.245 capability messages are exchanged followed by requests to establish logical channels for communication. Advantageously, the H.245 messages are exchanged via the gatekeepers so that bandwidth accounting on the tunnels between the tunnel switches is possible.

[0039] The media channels are routed end to end via the proxies using the IP addresses exchanged during set-up of the PPP sessions.

[0040] The L2TP tunnel between the two tunnel switches behaves as an SS7 trunk group. The gate-

keepers at either end of the tunnel are able to control the number of calls admitted allowing the network to be dimensioned for a grade of service as in normal telephony where all calls accepted have a guaranteed quality of service. The gatekeepers are also able to account for the total media components set up on the tunnel, this allows the available bandwidth to be dynamically shared amongst users and controlled by policies which can be based on congestion, user priorities and etc.

[0041]   It will be understood that the above description of a preferred embodiment is given by way of example only and that various modifications may be made by those skilled in the art without departing from the spirit and scope of the invention.

Claims

1. An arrangement for providing voice and media services over an IP network incorporating a plurality of nodes and in which connection oriented traffic is transported in tunnels via said nodes, the arrangement comprising means for providing signalling between said nodes, means for multiplexing the voice and media components to form a point to point protocol (PPP) session, and means for switching said PPP session end to end across the network under the control of said signalling.

2. An arrangement as claimed in claim 1, wherein said signalling comprises SS7 signalling.

3. An arrangement as claimed in claim 2, wherein said tunnels comprise Layer 2 Tunnelling Protocol (L2TP) tunnels and Multi Protocol Label Switching (MPLS) tunnels.

4. An arrangement as claimed in claim 3, wherein gatekeepers are provided one at either end of each said tunnel so as to control the number of calls admitted to that tunnel so as to ensure that all calls admitted have a guaranteed quality of service.

5. An arrangement as claimed in claim 4, wherein each said gatekeeper incorporates a call server function.

6. An arrangement as claimed in claim 5, wherein said nodes are arranged to exchange topology state packets so as to provide each said node with information on bandwidth availability

7. A method of providing voice and media services over an IP network incorporating a plurality of nodes, the method comprising providing SS7 signalling between said nodes, and multiplexing the voice and media components to form a point to point protocol (PPP) session which session is switched

end to end across the network under the control of said signalling.

8. An method of providing voice and media services over an IP network incorporating a plurality of nodes and in which connection oriented traffic is transported in tunnels via said nodes, the method comprising providing signalling between said nodes, multiplexing the voice and media services to form a point to point protocol (PPP) session, and switching said PPP session end to end across the network under the control of said signalling.

9. A method as claimed in claim 8, wherein said tunnels comprise Layer 2 Tunnelling Protocol (L2TP) tunnels and Multi Protocol Label Switching (MPLS) tunnels.

10. A method as claimed in claim 3, wherein gatekeepers are provided one at either end of each said tunnel, and the number of calls admitted to a said tunnel is controlled so as to ensure that all calls admitted to that tunnel have a guaranteed quality of service.

11. A method as claimed in claim 10, wherein each said gatekeeper is provided with a call server function.

12. A method as claimed in claim 11, wherein topology state packets are exchanged between said nodes so as to provide each said node with information on bandwidth availability.

13. A network architecture for Voice over IP services in which SS7 signalling is used between Voice over IP nodes and the media components between the VoIP terminals are multiplexed to form a PPP session which is switched end to end across the network.
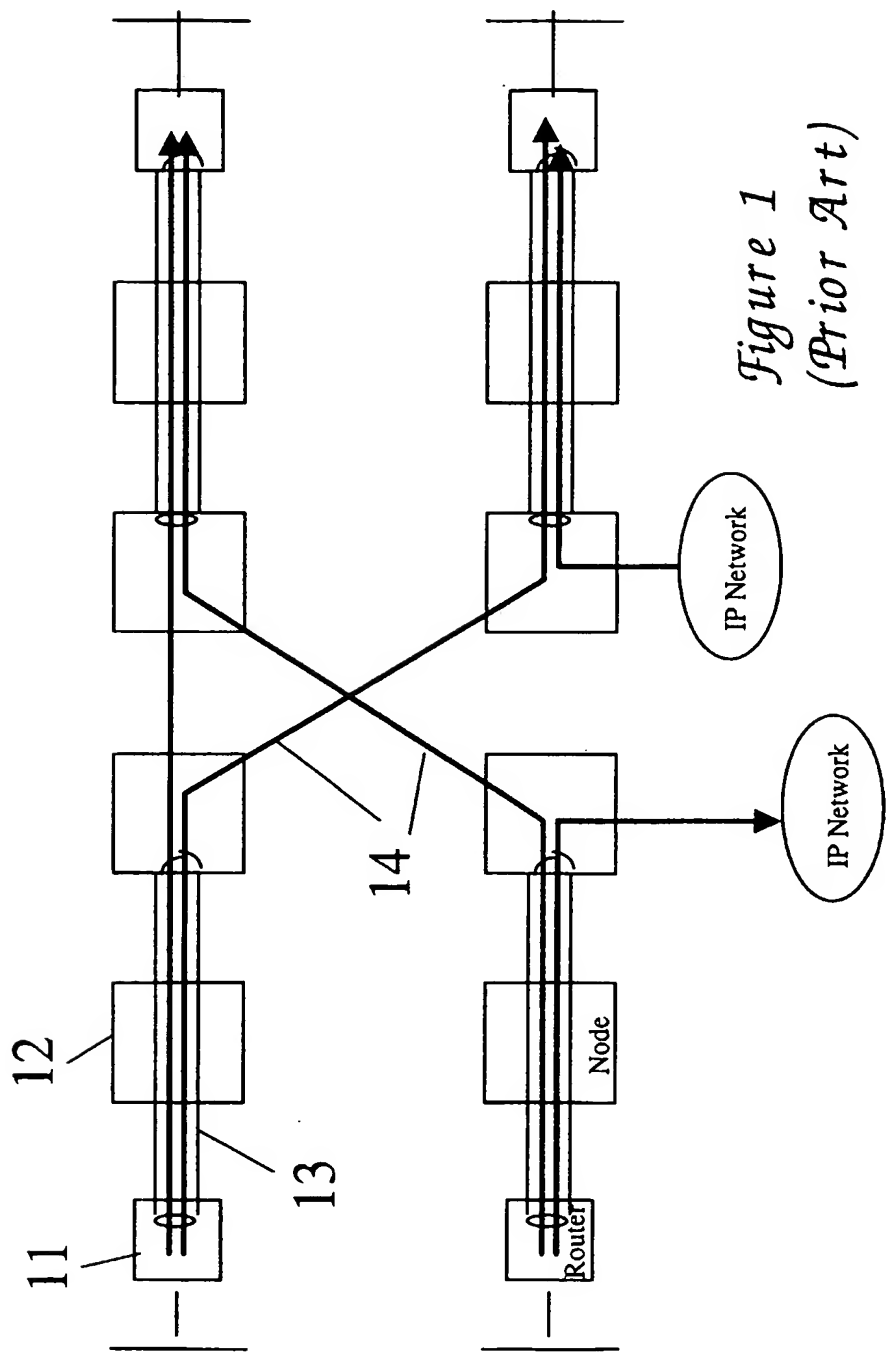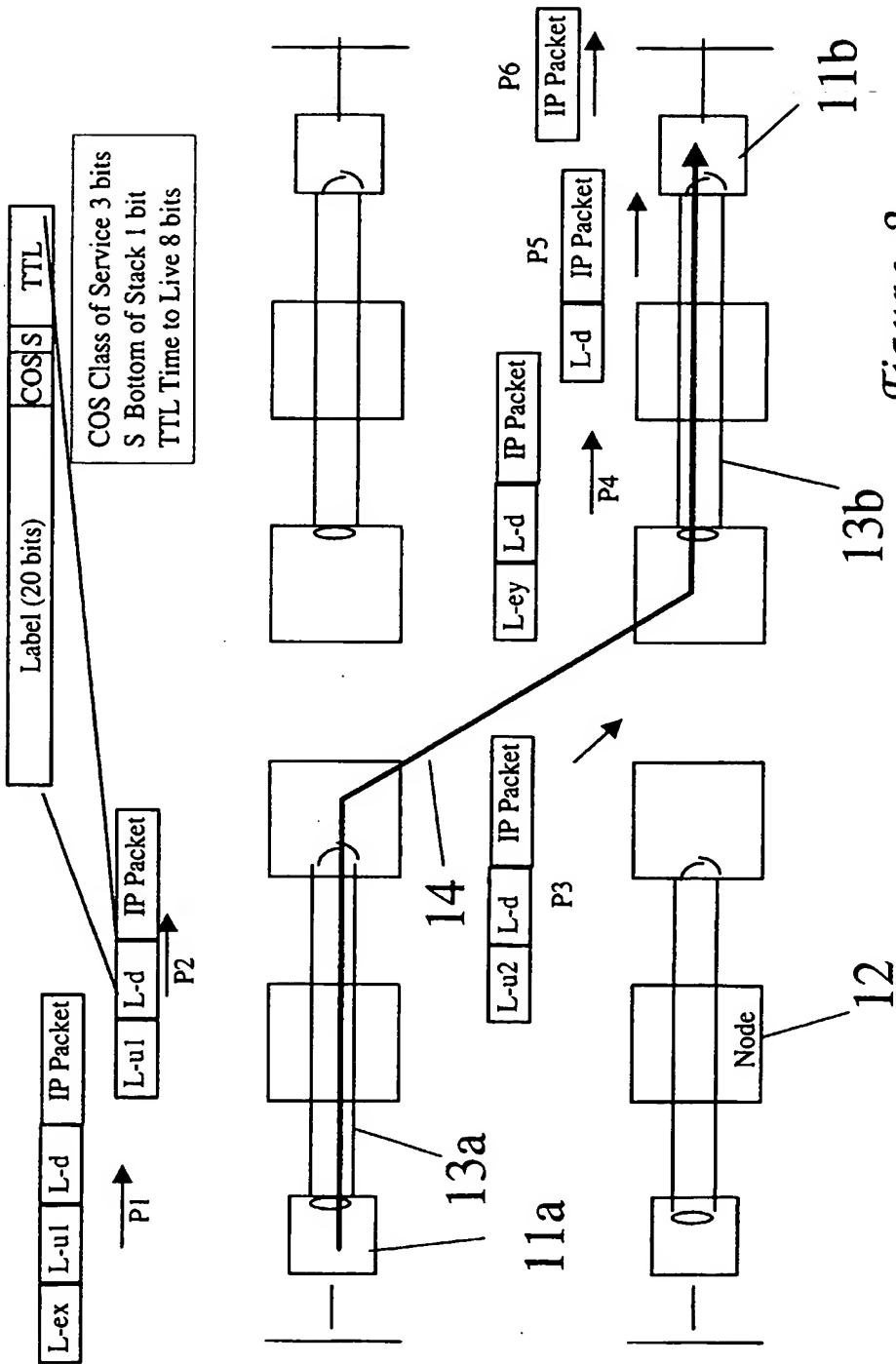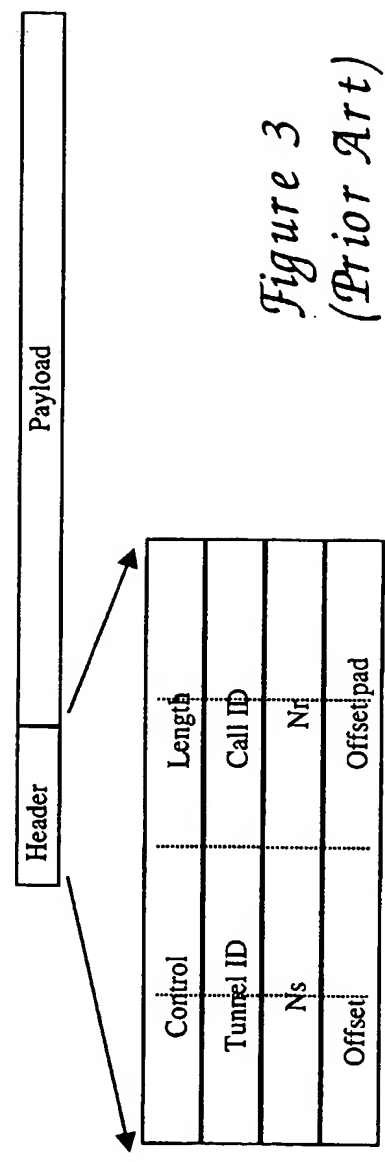
Figure 1
(Prior Art)

Figure 2
(Prior Art)

LAC   L2TP Access Concentrator
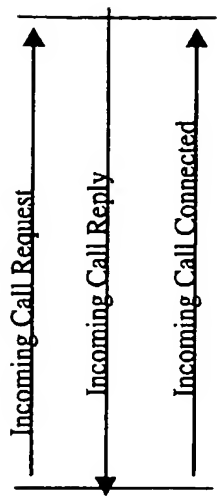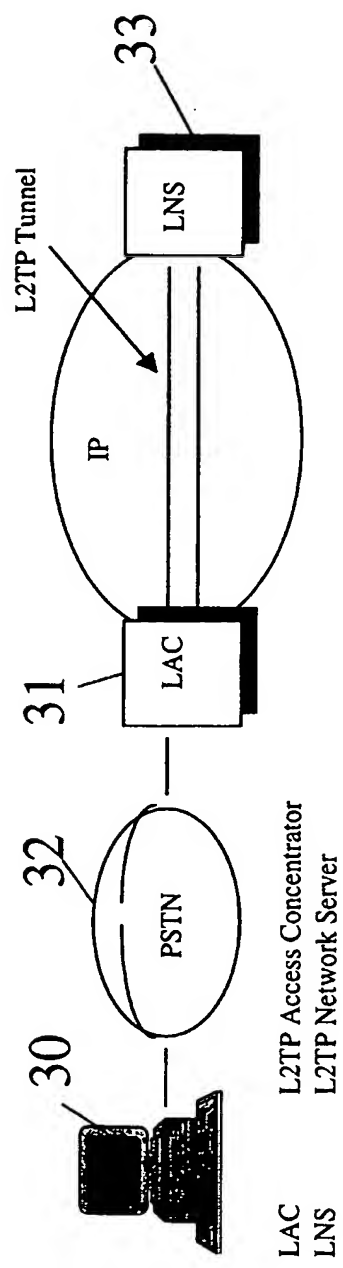LNS   L2TP Network Server

Incoming Call Request
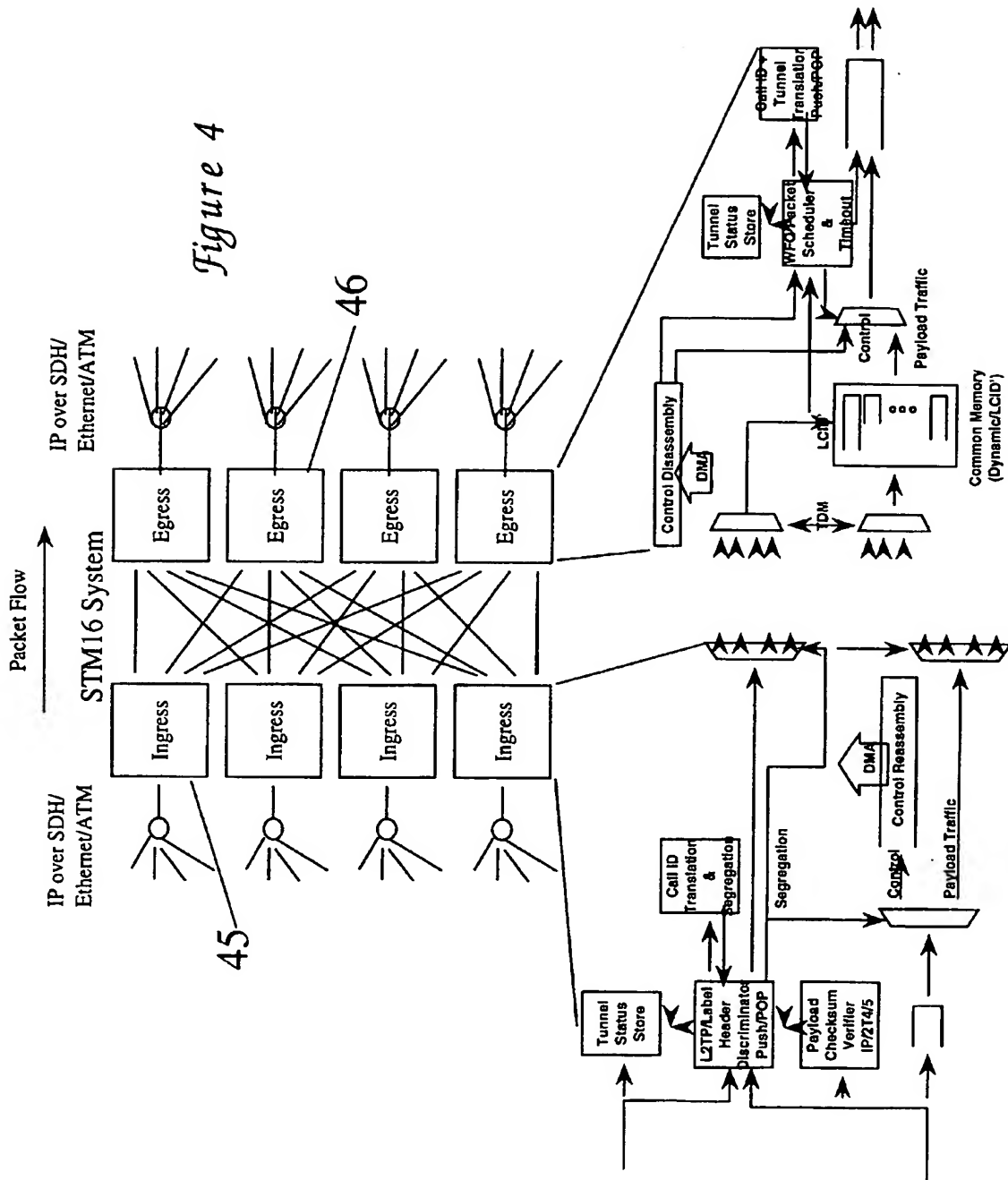Incoming Call Reply
Incoming Call Connected

Figure 3
(Prior Art)

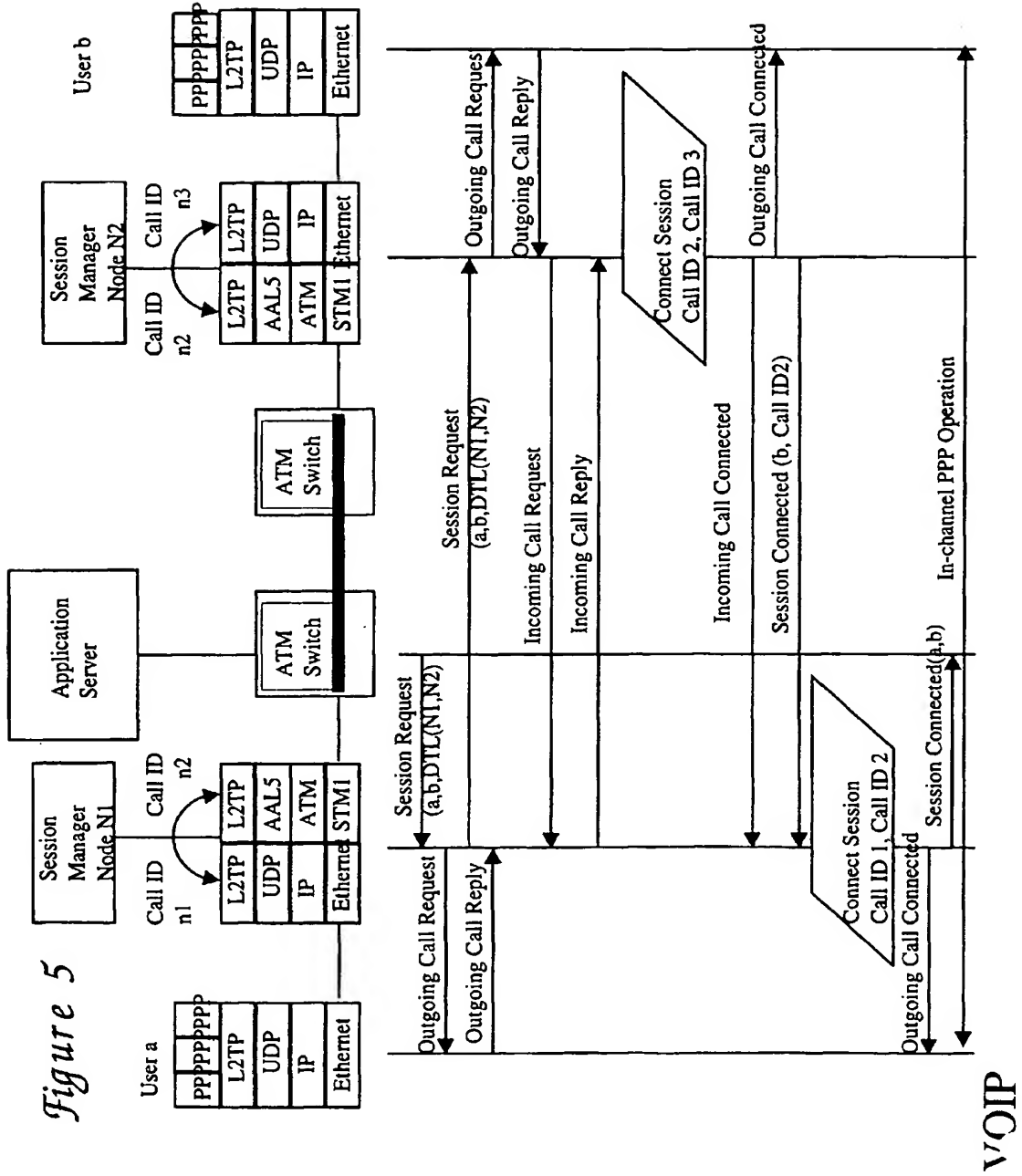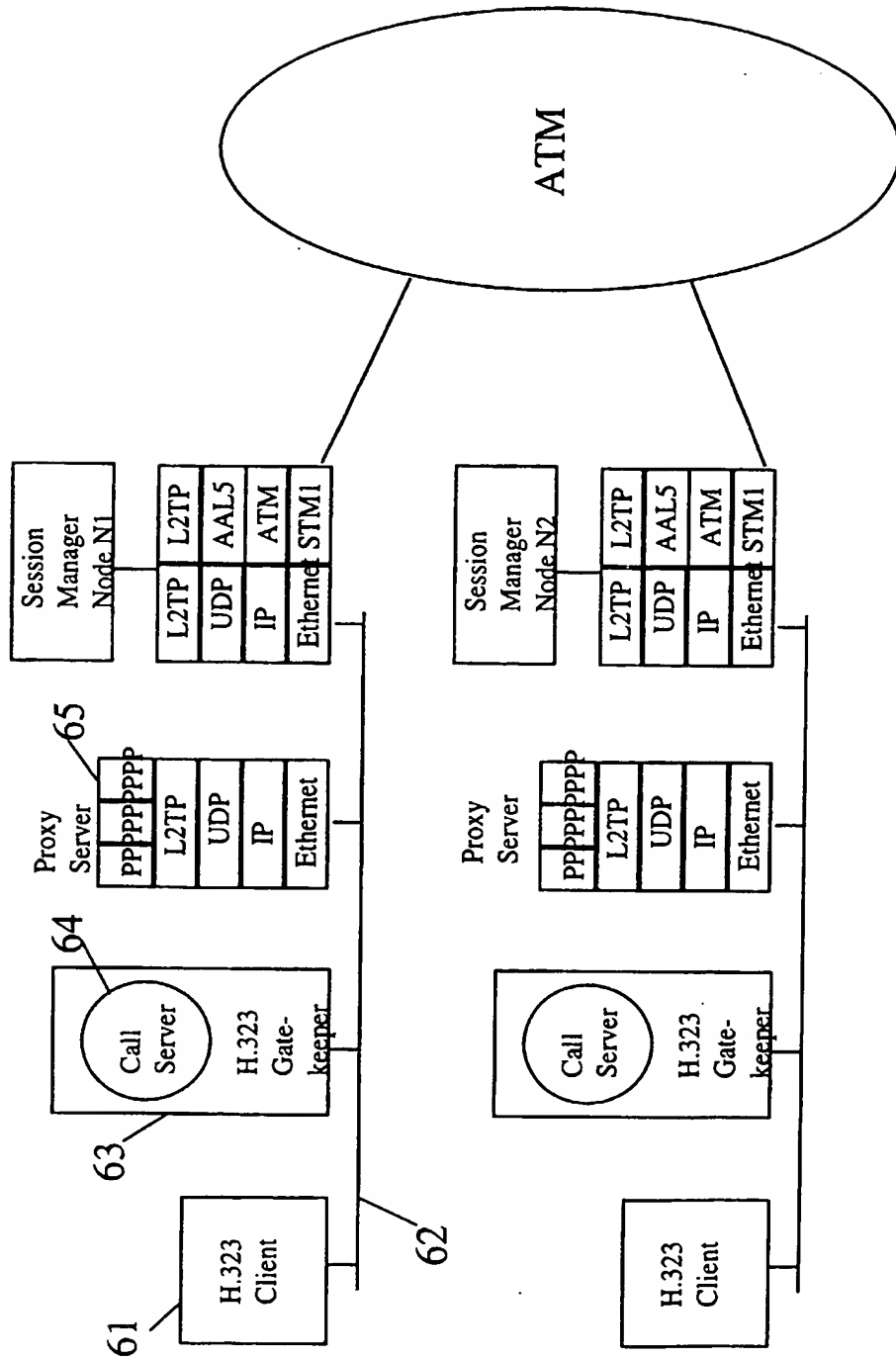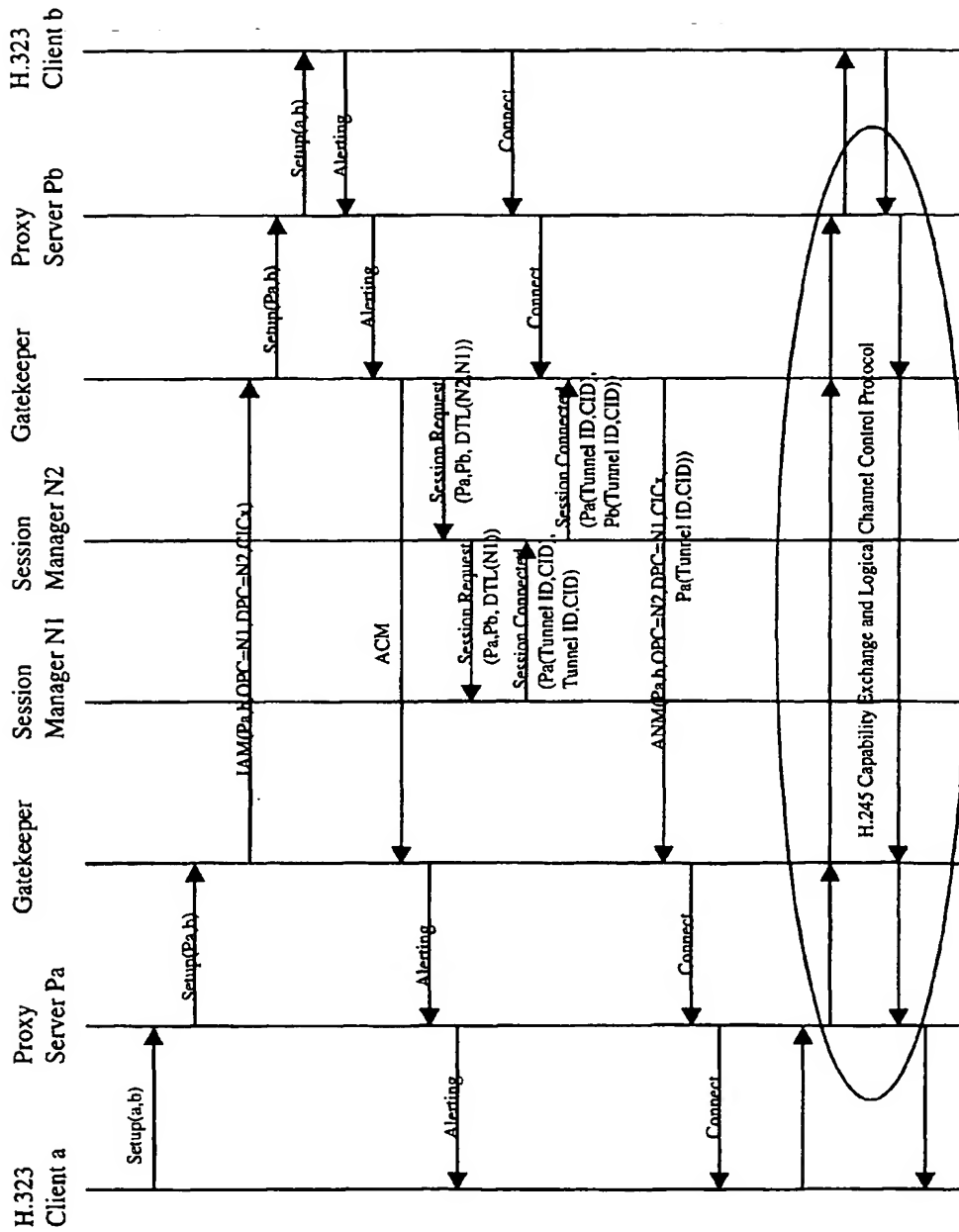Figure 4

Figure 5

Figure 6

Figure 7

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 99 30 8872

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	26 January 2000	Willems, B

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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    document

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ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.

EP 99 30 8872

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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